COURSE OF STUDIES

GRADE NINE SCIENCE

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A. PROGRAM RATIONALE AND PHILOSOPHY

"The aim of education is to develop the knowledge, the skills and the positive attitudes of individuals, so that they will be self-confident, capable and committed to setting goals, making informed choices and acting in ways that will improve their own lives and the life of their community."

Secondary Education in Alberta, 1985

Science education contributes to this overall aim of education in several ways:

- first, by providing learning experiences that help students understand and interpret the world in which they live
- second, by developing knowledge, skills and attitudes that support the intelligent and responsible application of science and technology, and
- third, by developing a foundation of knowledge, skills and attitudes that support further study of the sciences.

To achieve these purposes, the Junior High Science Program provides a broad range of learning experiences in the biological, physical and earth sciences. In continuity with the elementary and senior high programs, the junior high program provides opportunity for study or most of the major branches of sciences building in the experiences of the elementary school and providing a foundation for more formal studies at the senior high level.

In keeping with the developmental level of students, concepts are introduced through a broad range of experiences, including those based on first-hand investigation. Attention is also given to the development of information accessing and research skills and the use of technological materials (e.g., computers and interface devices). Learning based on these experiences are extended as students are given opportunities to reflect on their experiences, learning to discover and construct meaning through careful and focused thought. Learning activities are thus designed not only to illustrate established science ideas, but also to allow students to construct new meanings and find new applications to what they learn.

Learnings within the program are presented in contexts that illustrate the development and application of science. Frequent attention is given to the processes by which scientific knowledge is gathered, largely by involving students directly in the practice of scientific inquiry. Significant attention is also given to other contexts of science: in particular the application of science to the solution of practical problems, and the examination of the implications of science and technology with respect to personal and social impact. The processes of problem solving and decision making are given direct attention in learning activities: students are thus involved in ways that will stimulate their critical and creative thinking skills.

In broad terms, the intended outcome of the secondary science program is the development a scientifically literate citizenry. A scientifically literate person is one who:

- demonstrate a working knowledge and practical understanding of the sciences
- has the ability to evaluate scientific evidence
- understands the processes by which scientific knowledge is developed and can adapt those processes for personal use
- applies science concepts, theories and processes to the investigation of everyday problems
- understands the relationship of science and technology
- demonstrates awareness of how science and technology can function responsibly in a social context
- recognizes the limitations as well as the usefulness of science and technology in advancing human welfare, and
- demonstrates a continuing interest in science and technology

B. GENERAL LEARNER EXPECTATIONS

These general learner expectations are to be developed through the program as a whole with particular attention to be given in designated units, as identified in individual unit outlines. General learner expectations are listed in association with three major areas of emphasis:

Nature of Science
Science and Technology
Science, Technology and Society

Concepts, skills and attitudes have been identified for each of these three areas of emphasis as well as for specific units at each grade level. Note that each area of emphasis provides an overall context for learning basic scientific concepts and principles related to students' experiences. One of these contexts provides the primary basis for development of each unit in the program.

NATURE OF SCIENCE

Attitudes

Students will be encouraged to develop:

1. Curiosity about events and objects in the natural world.
2. Appreciation of the beauty and complexity of the natural world.
3. Respect for accuracy and precision.
4. Honesty and completeness in reporting and evaluating observable data.
5. Open-mindedness in considering alternative ideas and interpretations.
6. Critical-mindedness in evaluating inferences and conclusions.
7. Confidence in personal ability to design and conduct a scientifically investigation.

Science Inquiry Skills

Students will demonstrate:

1. Questioning
    - recognizing patterns and discrepant events
    - identifying and asking relevant questions
2. Proposing Ideas
    - hypothesizing
    - predicting
3. Designing Experiments
    - identifying and controlling variables
    - developing procedures
4. Gathering Data
    - observing
    - measuring
5. Processing Data
    - organizing and presenting data
    - identifying patterns and trends
6. Interpreting Data
    - inferring
    - developing theoretical explanations

Concepts

Students will demonstrate an understanding that:

1. Science is a disciplined way to develop explanations for natural phenomena.
2. Scientific knowledge is cumulative and subject to change.
3. Significant aspects of the scientific enterprise include:
    - observable data that can be repeatedly demonstrated in various places, at different times, by different investigators
    - experimentation (scientific inquiry) as a means to support, modify, or reject proposed ideas about natural phenomena
    - interpretations and conceptual inventions that are theoretical in nature

SCIENCE AND TECHNOLOGY

Attitudes

Students will be encouraged to develop the following attitudes:

1. Appreciation of the need for technological devices and processes to serve human needs.
2. Appreciation of the contribution of science to the solution of practical problems.
3. Awareness of alternatives in the approach to technological problems.
4. Respect for the creative and critical thinking processes.
5. Appreciation of good design (from an aesthetic as well as a functional perspective).
6. Willingness to take initiative in dealing with practical problems.
7. Confidence in personal ability to solve practical problems.

Technological Problems in Solving Skills

Students will demonstrate the following skills:

1. Understanding the purpose
    - identifying the purpose
    - identifying specific requirements (specifications)
2. Developing a Plan
    - identifying alternatives
    - planning and designing
3. Carrying Out the Plan
    - testing the design
    - troubleshooting
4. Evaluating
    - evaluating the design
    - evaluating the planning process

Concepts

Students will demonstrate an understanding that:

1. Science and technology are interrelated:
    - the development of new technologies may open new areas for scientific investigation
    - solving technological problems frequently involves the application of scientific knowledge.
2. Technology is a process of solving practical problems.
3. Significant aspects of the technological problem-solving process include:
    - approaching the problem in a planned way
    - development of a practical design as a means to support, modify, or reject alternative ideas for solving the problem.
    - creativity and inventiveness in developing solutions that achieve the intended purpose
    - critical thinking in the evaluation of potential solutions and in the identification of areas in which improvement might be made.
4. Technological development involves both products and processes.
5. Technologies arise from common practices and traditions as well as from the creative applications of scientific knowledge.

SCIENCE, TECHNOLOGY AND SOCIETY

Attitudes

Students will be encouraged to develop the following attitudes:

1. Appreciation of the need for informed decisions making at both personal and societal levels.

2. Appreciation of the contributions and limitations of scientific and technological knowledge to the societal decision-making process.

3. Confidence in using scientific and technological knowledge to inform personal decision making.

4. Commitment to the pursuit of knowledge and the responsible application of that knowledge.

5. Appreciation of different perspectives that bear upon the societal decision-making process.

6. Respect for the perspectives and viewpoints of others.

Decision-Making Skills

Students will demonstrate the following skills:

1. Identifying the Issue

2. Identifying the Alternatives

3. Researching
    - examining background information
    - examining perspectives on each alternative
    - identifying consequences of each alternative

4. Reflecting and Deciding
    - considering consequences
    - considering perspectives
    - building consensus

5. Taking Action
    - demonstrating responsibility through personal action
    - demonstrating responsibility through actions as a member of a group

6. Evaluating
    - evaluating effects of actions
    - evaluating the decision-making process used

Concepts

Students will demonstrate an understanding that:

1. Knowledge of science and technology helps inform the societal decision-making process.

2. Societal decision making aims at choosing actions most appropriate for existing circumstances by comparing and evaluating the consequences of alternative proposals.

3. The societal decision-making process works toward building a consensus. Significant aspects of social decision making include:
    - recognition of the advantages and limitations of scientific and technological knowledge for informing the process
    - consideration of other perspectives (e.g., economic, ethical, political), in addition to scientific and technological perspectives, in informing decision making about science related issues.
    - deliberation as a means to clarify, support, modify, or reject alternative proposals for action
    - recognition of the need for trade-offs in order to achieve workable solutions in science-technology-society problems.

4. Relationships among science and technology, and societal decision making occur at many levels:
    - developments in science and technology often significantly impact on society
    - societal needs and concerns often stimulate or influence technological problem solving and scientific inquiry.

5. Many of the effects of science and technology on society are unforeseen.

C. CONTENT

1. TOPICS OF STUDY

The program is comprised of six units at each grade level. Each unit focuses on a particular science topic and develops a learning context that contributes to the student's overall understanding of science and technology.

The instructional time for each unit varies, but at each level the program is based on 100 hours of instructional time.

2. REQUIRED/ELECTIVE COMPONENTS

Each unit of the program has a required component and an elective component, defined as follows:

The required component encompasses the knowledge, skills and attitudes that all students should be expected to acquire. This component comprises 80% of the program.

The elective component, which comprises 20% of the program, provides opportunities to adapt and enhance instruction to meet the diverse needs, abilities and interest of individual students. It encourages enrichment and remediation consistent with the content and objectives of the required component.

The program content for both the required component and the elective component is defined by the same statements of objectives.

3. OPTIONAL CONTENT

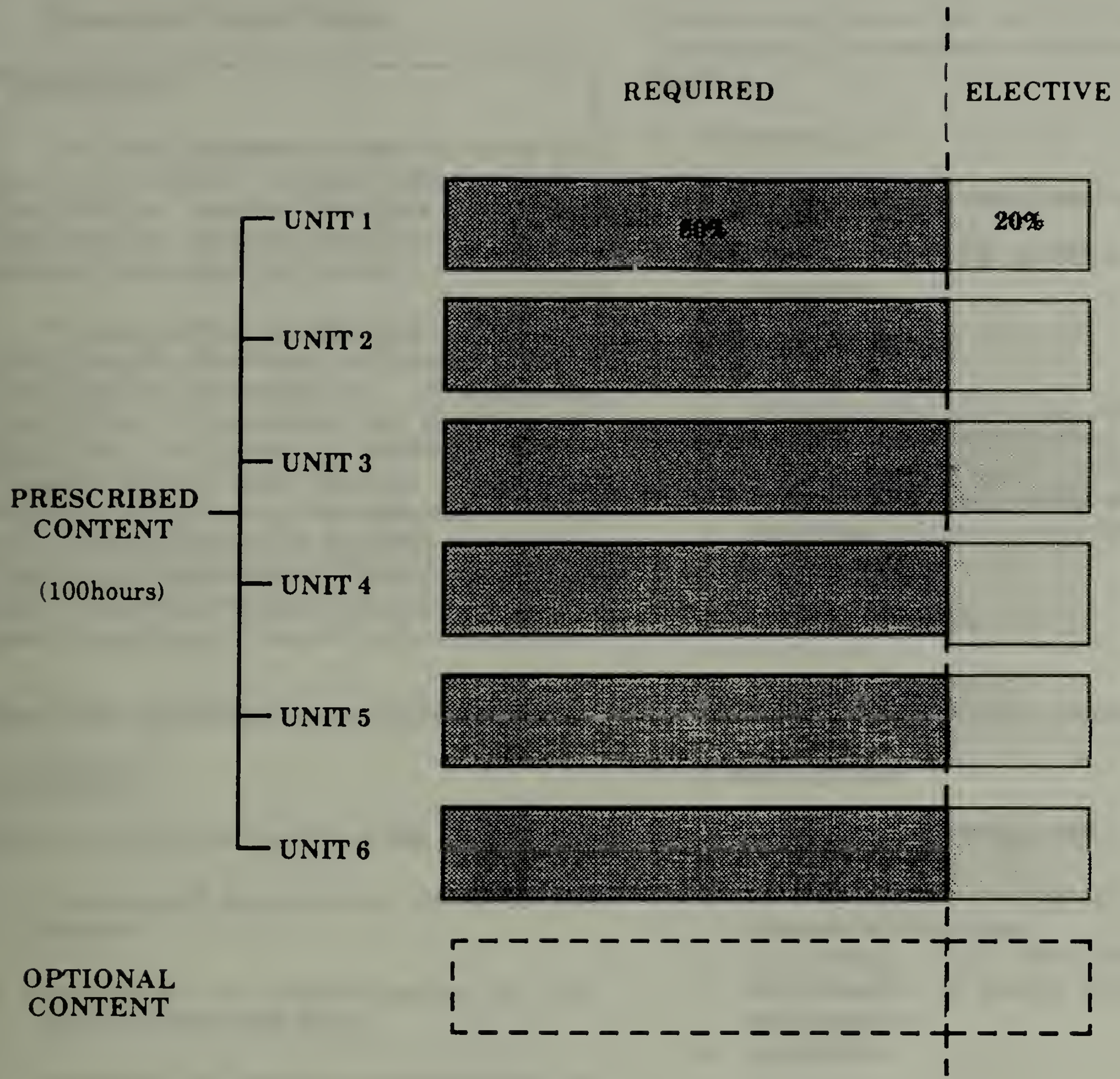
(Note: there will be no requirement that optional content be included within a school's Junior High Science Program.)

Instructional content that is provided beyond the mandatory 100 hours of instruction shall be deemed to be optional, Optional content to the program may take several forms:

- an extension of a prescribed unit
- a suggested option identified in the *Teacher Resource Manual*
- an option based on local choice

Selection of topics for development as optional units may be made at the local school levels based on local needs and resources. To assist the school in the choice and development of topics, brief outlines will be provided and, where available, resources will be identified. Optional topics may include include-units that have been developed or selected locally, subject to the following provisions being met.

- All program content must support the overall goals of the program.
- Inclusion of optional content must not detract from the achievement of required program objectives or from elective content associated with the required program.
- Optional content must not duplicate or unduly overlap content to be developed in a subsequent year of the secondary science program.


REQUIRED
ELECTIVE
UNIT 1
80%
20%
UNIT 2
UNIT 3
UNIT 4
UNIT 5
UNIT 6
PRESCRIBED CONTENT
(100hours)
OPTIONAL CONTENT

GRADE NINE PROGRAM

1. Diversity of Living Things

OVERVIEW

The major emphasis of this unit is on the nature of science. Opportunities are also provided to support learning regarding technologies and the relationship among science, technology and society.

This unit surveys the diversity of living things, using scientific observation and classification as the basis for interpretation. It examines variability in structures and functions of organisms, with particular attention to the adaptive value of those features. The role of variation in behaviour is also examined. Natural and artificial selection are identified as processes that can alter the diversity of living things through the development or extinction of species.

SPECIFIC LEARNER EXPECTATIONS

ATTITUDES

Students will be encouraged to develop:

1. awareness and appreciation of the diversity of life forms
2. awareness and appreciation of the interrelatedness of life forms
3. recognition that systems of classification and nomenclature are human inventions (rather than something inherent in the materials being classified)
4. appreciation of the usefulness of classification systems
5. awareness of the effects of human actions in increasing or decreasing the diversity of living things

SKILLS

Students will demonstrate the following science inquiry skills, with emphasis on those that appear in boldface.

1. Questioning
   - **recognizing patterns and discrepant events**
   - **identifying and asking relevant questions**
2. Proposing Ideas
   - **hypothesizing about the relationships between specific living things**
   - **hypothesizing about the adaptive value of plant and animal structures**
   - **predicting adaptive responses of plants and animals**
3. Designing Experiments
   - identifying variables
   - developing experimental procedures
4. Gathering Data
   - **observing variation within a group of living things**
   - **identifying and describing distinctive features of organisms**
   - **observing and describing the distribution of living things in an environment**
   - **measuring**
5. Processing Data
   - **classifying familiar objects or living things, using a dichotomous key**
   - **organizing and presenting data**
6. Interpreting Data
   - **inferring evidence of relationships between living things**
   - **inferring risks of extinction based on characteristics of particular living things and knowledge of changing environmental conditions**
   - **interpreting variation of living things**
   - **developing theoretical explanations**

CONCEPTS

1. Living things show a diversity of structural and behavioural adaptations.

Students will be expected to:

- demonstrate awareness of the diversity of forms of life
- observe and identify examples of variation in the structure of living things
- identify animal structures that play a role in locomotion, securing of food, and avoidance of predators
- identify plant structures that serve needs for obtaining and distributing nutrients, reproduction and protection
- infer environmental conditions for which particular structures are adaptive
- identify and describe examples of mutual dependency between plants and/or animals
- identify and describe examples of mimicry in plants and animals
- identify and describe examples of adaptation to a single food source or to a narrow range of food sources

2. Artificial selection provides a basis for the enhancement of desired characteristics of domesticated plants and animals

Students will be expected to :

- describe the process of selective breeding
- describe examples of the use of selected breeding to enhance desired characteristics of a plant or animal

3. The concept of natural selection provides a basis for interpreting the evolution and extinction of species.

Students will be expected to:

- identify and describe examples of specialization within related groups of organisms
- identify evidence that has led to the concept of natural selection
- describe the role of natural selection in evolutionary theory

4. Classification of living things is based on similarities and differences among organisms.

- construct and use a dichotomous key
- describe the Linnaean classification system
- identify advantages of using the Linnaean classification system as the basis for scientific classification (as opposed to the use of common names)
- identify the taxonomic levels used in scientific classification
- describe or define the intended meaning of the term 'species', and identify problems in its interpretation
- infer the relatedness of species on the basis of their scientific classification
- describe the contribution of research to expanding the number of known species and to scientific knowledge of those species
- recognize that growth in scientific knowledge has led to the development of classification systems based on more than two kingdoms.

6. Individual living things can be interpreted as members of groups of organisms that share common features.

- identify general features of major groups of living things; e.g., skeletons and exoskeletons, specialized organs, limbs
- identify and describe life cycles of plants and animals

2. Fluids and Pressure

OVERVIEW

The major emphasis of this unit is on science and technology. Opportunities are also provided to support learning regarding the nature of science and the relationship among science, technology and society.

This unit provides an introduction to the properties of fluids and examines the applications of fluids within the natural world and in technological devices. Fluid technologies studied include those which involve the movement of fluids and those which involve transfer of mechanical force. Opportunities are provided in the unit for students to construct devices that will perform specified functions and to make improvements to those devices. Students examine approaches used in existing technologies and consider alternatives in their design.

SPECIFIC LEARNER EXPECTATIONS

ATTITUDES

Students will be encouraged to develop:

1. awareness that practical problems can often be solved in multiple ways
2. confidence in personal ability to solve practical problems
3. respect for the diversity of approach exhibited by others in their search for solutions to practical problems
4. appreciation of the aesthetic and functional values of aerodynamic and hydrodynamic design
5. awareness of the presence of fluids as part of living things, environments and technological devices

SKILLS

Students will demonstrate the following technological problem-solving skills, with emphasis on those that appear in boldface:

1. Understanding the Problem
   - **identifying the purpose**
   - **identifying specific requirements (specifications)**

2. Developing a Plan
   - **designing a device or system that will accomplish a specific practical task through application of fluid principles**
   - **identifying alternative design solutions in the building of a device or system**

3. Carrying Out the Plan
   - **testing a design by construction of a device or system**
   - **troubleshooting a design: identifying and correcting practical problems in a fluid-mechanical device or system**
     - **identifying problems**
     - **improvising practical remedies to problems encountered**

4. Evaluating
   - **evaluating the design**
   - **evaluating the planning process**

CONCEPTS

1. Liquids and gases exhibit fluid properties that are significant to their application in technological devices.

   Students will be expected to:

   - describe the compressibility of liquids and gases
   - interpret the compressibility of liquids and gases in terms of particle theory
   - compare the viscosity of different liquids by use of a simple lab test
   - predict the effects of temperature changes on viscosity of fluids
   - recognize flow rates as an indicator of the viscosity of liquids
   - identify applications where viscosity of fluids is a significant factor
   - distinguish between applications that require a compressible fluid and applications that require a non-compressible fluid

2. Forces within fluids are transferred in all directions

Students will be expected to:

- describe the response of fluids to gravity
- predict the response of fluids to external pressure
- measure a buoyant force
- construct and calibrate a simple hydrometer
- use a hydrometer in measuring the density of a liquid
- predict changes in liquid density that result from temperature changes and from change in solution concentration
- predict changes in buoyant force that result from changes in fluid density
- identify and interpret technologies that are based on buoyant force

3. Hydraulic systems provide the basis for the application and transfer of forces.

Students will be expected to:

- predict the force exerted on a surface based on knowledge of pressure and surface area
- predict changes in force exerted resulting from an increase in the surface area over which pressure acts
- infer the need for strength in pressurized vessels

4. Various technologies are used in the movement and control of fluids.

Students will be expected to:

- identify fluid systems in living things and human-made devices
- interpret the function of fluid systems within living things and human-made devices.
- construct a diagram to illustrate components in a fluid system
- construct a functional fluid system using materials provided
- interpret the operation of various kinds of valves
- interpret the operation of the human heart
- interpret and explain the operation of pumps

5. The study of fluid movement has led to development of aerodynamic and hydrodynamic design.

Students will be expected to:

- predict the effect of design on drag around an object traveling through a fluid
- design a streamlined device

3. Heat Energy: Transfer and Conservation

OVERVIEW

The major emphasis of this unit is on science and technology. Opportunities are also provided to support learning regarding the nature of science and the relationship among science, technology and society.

This unit examines heat energy transfer and related applications. A study of conduction, convection and radiation provides the basis for examination of technologies for the containment of heat energy and for the transfer of heat energy. Particular focus is given to the need to conserve energy resources through efficient use.

SPECIFIC LEARNER EXPECTATIONS

ATTITUDES

Students will be encouraged to develop:

1. awareness of dangers of using flames in proximity to flammable materials
2. awareness that practical problems can often be solved in multiple ways
3. confidence in personal ability to solve practical problems
4. respect for the diversity of approach exhibited by others in their search for solutions to practical problems
5. commitment to the conservation of energy resources through efficiency of design and efficiency in energy use

SKILLS

Students will demonstrate the following science inquiry skills, with emphasis on those skills that appear in boldface.

1. Understanding the Problem
   - **identifying the purpose**
   - **identifying specific requirements (specifications)**
2. Developing a Plan
   - **identifying alternative approaches to the design of insulated containers**
   - **planning and designing for heat transfer**
   - **planning and designing for insulation**
3. Carrying Out the Plan
   - **testing the designs**
     - **construction of an insulated container**
   - **troubleshooting the designs**
     - **identifying and correcting sources of heat loss**
4. Evaluating
   - **evaluating the effectiveness of different insulating materials and designs for insulation**
   - **evaluating the planning process**

CONCEPTS

1. The term 'heat' is used in reference to energy gained or lost by a material as it interacts with other materials.

   Students will be expected to:

   - infer heat gain or heat loss in practical activities
   - distinguish between heat and temperature
   - interpret temperature changes in terms of particle theory
   - identify heat losses or gains in terms of number of joules

2. Heat generally moves from hot bodies to cooler ones.

   Students will be expected to:

   - predict temperature changes that will result from mixing various quantities of water of different temperatures
   - interpret information regarding the specific heats of particular materials
   - compare the specific heat of solids, liquids and gases.

3. Heat can be transferred by conduction, convection and radiation.

Students will be expected to:

- interpret conduction in terms of particle theory
- compare conduction rates of materials based on experimental data
- identify and interpret applications of heat conduction
- predict the flow pattern of a fluid as it is heated
- identify and interpret applications of heat convection
- identify factors which effect rates of radiation
- identify and interpret examples of heat radiation

4. Heat transfer can be controlled through selection of appropriate materials and by use of appropriate design.

Students will be expected to:

- identify applications in which heat transfer is controlled
- design and construct an insulated container
- compare the effectiveness of alternative materials and designs for heat transfer in domestic applications (e.g., in cooking devices and home heating)
- compare the effectiveness of alternative materials and approaches to insulation in domestic applications (e.g., refrigerated containers and insulated homes)
- interpret the effect of clothing materials and design on the retention or transfer of heat
- describe and demonstrate a technique for comparing the effectiveness of different kinds of insulating materials
- identify effective insulating materials

5. Solar heating involves the absorption and transfer of energy from solar radiation.

Students will be expected to:

- describe general principles of passive and active solar heating
- identify functions of components used in a solar heating system
- design and construct a model solar heating device

4. Electromagnetic Systems

OVERVIEW

The major emphasis of this unit is on science and technology. Opportunities are also provided to support learning regarding the nature of science and the relationship among science, technology and society.

This unit examines principles of current electricity which provide the basis for production, control and use of electrical energy. Principles of basic circuitry are introduced and these principles are applied in association with technological concepts of systems, subsystems and control. Extensive opportunities are provided for students to apply these concepts and principles to the solution of practical problems.

SPECIFIC LEARNER EXPECTATIONS

ATTITUDES

Students will be encouraged to develop:

1. safety attitude regarding the use of electrical devices

2. awareness that practical problems can often be solved in multiple ways

3. confidence in personal ability to solve practical problems

4. respect for the diversity of approach exhibited by others in their search for solutions to practical problems

SKILLS

Students will demonstrate the following science inquiry skills, with emphasis on those skills that appear in boldface.

1. **Understanding the Problem**
   - **identifying the purpose**
   - **identifying specific requirements (specifications)**

2. **Developing a Plan**
   - **designing an electrical device that will accomplish a specific task through the controlled application of electrical energy**
   - **identifying alternative design solutions in the building of an electrical device**

3. **Carrying Out the Plan**
   - **testing the design**
     - **construction and testing of a simple electrical device**
     - **construction and testing of an electrical device that involves two or more subsystems**
   - **troubleshooting the design: identifying and correcting practical problems in an electrical device**
     - **identifying problems in design or construction of the circuit**
     - **identifying problems caused by materials or components used**

4. **Evaluating**
   - **evaluating the design**
     - **evaluating alternative designs for an electric battery**
     - **evaluating alternative designs for a simple electrical device**
   - **evaluating the planning process**

CONCEPTS

1. Current electricity is potentially dangerous

   Students will be expected to :

   - assess the potential danger of an electrical device by referring to the voltage of the device
   - distinguish between devices that might be used safely in experimental studies and those that would not be appropriate
   - recognize dangerous procedures
   - recognize equipment that is in an unsafe condition for use

2. Specialized technologies for the production of current electricity are based on chemical, photoelectric or thermoelectric principles.

Students will be expected to:

- describe the general design and function of a simple wet cell
- describe a process for testing the effectiveness of different materials for use within a wet cell
- describe the design of cells and batteries in common usage
- identify practical problems that designers of batteries have attempted to solve, and describe approaches that have been used to solve these problems (e.g., excessive size and weight, portability, durability)
- construct a thermocouple and demonstrate its effectiveness
- identify practical applications for which the use of photo-electric or thermo-electric devices are appropriate

3. Electromagnetic effects provide a means for conversion of mechanical energy to electrical energy, or electrical energy to mechanical energy.

Students will be expected to:

- describe evidence of electromagnetic effects; e.g., electromagnetic effects caused by a current flowing through a wire
- construct a simple galvanometer by use of a compass and wire
- use a meter to measure voltages and amperages within a circuit
- demonstrate the generation of electricity by movement of a magnet through a coil
- interpret the operation of a simple generator
- describe the design of a simple electric motor
- interpret the operation of an electric motor
- design and construct a device that operates on the basis of electromagnetic force (e.g., electromagnet, buzzer or motor)

4. Electrical devices are based on circuits.

Students will be expected to:

- construct a simple circuit using materials provided
- design and construct series and parallel circuits
- predict the effects of linking electrical loads in series and in parallel
- using materials provided, design a circuit that will perform a given function
- construct and interpret circuit diagrams
- identify short circuits in a sketch of a curcuit or in an actual circuit

5. Electrical resistance can be used to control the flow of electricity in a circuit or to produce heat and light.

Students will be expected to:

- construct and use a simple variable resistor using materials provided
- describe the effect of resistance on electron flow in a simple circuit
- predict the effects of resistors on electron flow in series and parallel circuits (based on placement of resistors at different locations in those circuits)
- interpret the design of devices that produce heat and light based on electrical resistance

6. Electromechanical systems can be designed to perform simple or complex functions.

Students will be expected to:

- describe the operation of various kinds of switches and control devices (e.g., switches controlled by direct operator contact, timed switches, magnetically controlled switches, relays, diodes and transistors)
- use various kinds of switches and controls in a simple circuit
- design a circuit/construction that will perform a function then shut off when the function has been completed
- design a circuit/construction that will perform one function, and proceed to a second function when the first is completed
- design a circuit/construction that will respond to a changing environmental condition (e.g., temperature or light)
- recognize systems and subsystems within household electromechanical devices (e.g., record players, electric washers)
- interpret the function and operation of electronic control devices in common domestic applications (e.g., thermostats, timers)

5. Chemical Properties and Changes

OVERVIEW

The major emphasis of this unit is on science, technology and society. Opportunities are also provided to support learning regarding technologies and the relationship of science, technology and society.

This unit introduces the chemical properties of common substances. Students learn to distinguish between chemical and physical change and to recognize examples of chemical changes that occur in their environment. Factors that affect reaction rates are studied. Particular focus is given to the chemistry of acids and bases.

SPECIFIC LEARNER EXPECTATIONS

ATTITUDES

Students will be encouraged to develop:

1. awareness that all materials have a chemical composition

2. awareness of dangers in handling reactive chemicals

3. adoption of a prudent approach to the handling of all chemicals, especially those that are unfamiliar to the user

4. awareness of consistency in properties and reactions: recognition that chemical events can be viewed as predictable consequences of given conditions rather than as random or magical in occurrence

SKILLS

Students will demonstrate the following decision-making skills, with emphasis on those skills that appear in boldface.

1. Questioning

- **recognizing patterns and discrepant events**
- **identifying and asking pertinent questions**

2. Proposing Ideas

- **hypothesizing relationships between observed chemical phenomena**
- **predicting the nature and rate of chemical reactions**

3. Designing Experiments

- **identifying variables that may affect reaction rates**
- **developing experimental procedures:**
  - **for the safe handling of materials**
  - **for testing and observing physical and chemical properties**
  - **for testing and observing reaction rates**

4. Gathering Data

- **observing physical and chemical properties of materials**
- **identifying and describing distinctive features of particular chemicals**
- **measuring**
  - **measuring physical properties of materials**
  - **measuring reaction rates**
  - **measuring pH**

5. Processing Data

- **organizing and presenting data**
- **recognizing patterns and trends in the properties of materials**

6. Interpreting Data

- **inferring evidence of chemical reaction**
- **developing theoretical explanations**

CONCEPTS

1. Materials have observable and measurable properties

Students will be expected to:

- describe the crystalline structure of materials examined
- measure the melting point of a material
- measure the density of a material
- measure the solubility of a material
- distinguish between materials that are relatively reactive and those which are not

- identify and use appropriate safety procedures in the handling and observation of chemical materials

2. Changes in materials may be classified by reference to the properties of the materials that are affected.

The student will be expected to:

- distinguish between chemical and physical properties
- recognize and describe evidence of chemical change in materials (e.g., energy gains or losses, changes in physical properties)
- identify examples of physical change
- classify changes in materials as chemical or physical

3. Acidity (pH) is a measurable characteristic of liquid solutions.

Students will be expected to:

- recognize dangers in the use of acids and bases, particularly in concentrated forms
- describe the effects of acid-base reactions
- describe the effects of acids and bases on other materials
- identify pH by use of various indicators
- identify the presence of acids and bases in household products

4. Common household substances have physical and chemical properties.

- identify chemicals commonly found in the home (e.g., in foods and in cleaning materials)
- describe the physical and chemical properties of some common household materials
- distinguish between different household materials on the basis of physical and chemical properties
- classify household chemicals according to their hazardous properties and appropriate conditions for storage

5. Rates of reaction are found to vary with the conditions of the reacting materials.

- predict/describe effects of changing the concentration of materials on rates of reaction
- predict/describe effects of changing the size of particles on rates of reaction
- predict/describe effects of changing temperature on rates of reaction
- identify dangers in potentially explosive reactions
- observe and measure heat generated in chemical reactions

6. Oxidation and corrosion reactions can be controlled with the use of chemical and physical means.

- identify examples of oxidation and corrosion
- describe physical and chemical means of preventing corrosion
- evaluate means of preventing oxidation or corrosion in particular applications

6. Environmental Quality

OVERVIEW

The major emphasis of this unit is on the relationship of science, technology and society. Opportunities are also provided to support learning regarding technologies and the nature of science.

In this unit, students are introduced to the idea of environmental quality and to the role of science in monitoring that quality. A variety of environmental quality indicators are considered. The central idea of the unit is that personal and public decision making regarding environmental quality is needed, and that the decision-making process should be informed by knowledge of environments and by objective assessments of environmental impacts.

Environmental concepts and skills developed in the unit provide a basis for observing and interpreting environmental changes. Extensive attention is given to human interventions within environments and the impacts of those interventions both in the short term and in the long term.

SPECIFIC LEARNER EXPECTATIONS

ATTITUDES

Students will be encouraged to develop:

1. awareness of the effects that environmental quality has on the health and well-being of living things

2. awareness of impacts of human actions on environmental quality

3. awareness of the role of scientific knowledge in informing environmental decision making

4. recognition of limits in current knowledge regarding environments and appreciation of the difficulties that these limits can create for personal and public decision making

5. respect for the perspectives and viewpoints of others

6. concern for and commitment to the maintenance of environmental quality

SKILLS

Students will demonstrate the following science inquiry skills.

1. Identifying issues and concerns regarding environmental quality

2. Identifying alternatives regarding actions that which have potential impacts on environments

3. Researching

   - examining background information regarding potential alternatives
   - examining personal, social and environmental perspectives on each alternative
   - identifying consequences of each alternative

4. Reflecting and Deciding

   - considering alternatives
   - considering perspectives
   - building consensus

5. Taking Action

   - demonstrating responsibility through personal actions
   - demonstrating responsibility in actions as a member of a group

6. Evaluating

   - evaluating effects of actions
   - evaluating the decision-making process used

CONCEPTS

1. Human actions modify environments through direct changes to living things, water, air and land; also through indirect effects.

   Students will be expected to:

   - describe examples of direct changes to environments that occur as a result of resource extraction, agriculture and/or human settlement
   - describe examples of changes to environments that occur as indirect consequences of human actions and lifestyles

2. Environmental quality is used in reference to the ability of environments to be life-supporting. A variety of biotic and abiotic factors are used as indicators of environmental quality

   Students will be expected to:

   - identify abiotic factors in an environment which might affect the health and distribution of living things in that environment (e.g., available oxygen in water, presence of solids in air or water)
   - interpret the quality of an environment in terms of the variety of life forms it supports
   - describe effects of removal of selected species on other species that live in an environment; e.g., effect of removal of soil fauna on the quality of soil
   - identify indicators of water quality (e.g., dissolved oxygen, presence of bacteria)
   - identify indicators of soil quality (e.g., depth of soil, aeration/compaction, presence of minerals)
   - identify indicators of air quality (e.g., presence of polluting gases, presence of particulates)

3. Pollutants are materials added to environments which negatively affect the quality of that environment.

   Students will be expected to:

   - identify household, municipal and industrial materials that comprise major sources of pollution in the local area
   - identify components within these wastes that have known negative effects
   - identify mechanisms by which these pollutants are added to the environment
   - describe concentration of materials in milligrams per gram or in parts per million
   - describe procedures used in measuring the presence of a chemical material in an environment. (An example of local interest may be chosen.)

4. Materials added to an environment remain in that environment until they are moved or until they are converted to another form

   Students will be expected to:

   - distinguish between wastes that are biodegradable in relatively short periods or time, and those that are not biodegradable
   - identify components of a waste product that can dissolve or be transported by water
   - describe the effect of ground and surface water movements on the distribution of pollutants
   - recognize waste disposal processes as involving one or more of the following processes: conversion of wastes, reintroduction of materials to the environments in original forms, and long term containment and storage
   - describe techniques used locally for disposal of a waste substance
   - identify points at which pollutants may enter food chains (particular emphasis on human foods)

5. Scientific knowledge contributes to the environmental decision-making process.

Students will be expected to:

- identify contributions of science to societal decision-making regarding an environmental issue
- identify considerations and perspectives that contribute to the decision-making process
- identify alternative actions in response to an environmental issue and infer possible consequences of those actions
- identify consequences of inaction on environmental issues

6. Decisions at the personal level affect environmental quality

Students will be expected to:

- identify personal actions that can result in less waste production
- identify personal actions that help to assure that disposal of wastes occurs with minimal environmental impact
- identify personal actions which can contribute responsibly to societal action regarding an environmental issue

LB 1629-5 A3 A35 1984 GR-7-9
ADD-SC-09 1989
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